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Original Article

Effectiveness of cognitive-behavioral therapy on nutrition improvement and weight of overweight and obese adolescents: A randomized controlled trial

Seyedeh Fatemeh Miri [a, 1], Maryam Javadi [b, **, 1], Chung-Ying Lin [c, 1], Mark D. Griffiths [d, 1], Maria Björk [e, 1], Amir H. Pakpour [a, e, *, 1]

[a] Social Determinants of Health Research Center, Qazvin University of Medical Sciences, Qazvin, Iran
[b] Children Growth Research Center, Qazvin University of Medical Sciences, Qazvin, Iran
[c] Department of Rehabilitation Sciences, Faculty of Health and Social Sciences, Hong Kong Polytechnic University, Hung Hom, Hong Kong
[d] International Gaming Research Unit, Psychology Department, Nottingham Trent University, Nottingham, United Kingdom
[e] Department of Nursing, School of Health and Welfare, Jönköping University, Jönköping, Sweden

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ABSTRACT

Aim: To assess the effectiveness of a cognitive-behavioral treatment (CBT) program on weight reduction among Iranian adolescents who are overweight.
Methods: Using a randomized controlled trial design, 55 adolescents who were overweight (mean [SD] age = 14.64 [1.69] years; zBMI = 2.18 [0.65]) were recruited in the CBT program and 55 in the treatment as usual (TAU; mean age = 14.88 [1.50]; zBMI = 2.09 [0.57]) group. All the participants completed several questionnaires (Child Dietary Self-Efficacy Scale; Weight Efficacy Lifestyle questionnaire; Physical Exercise Self-Efficacy Scale; Pediatric Quality of Life Inventory; and self-reported physical activity and diet) and had their anthropometrics measured (height, weight, waist and hip circumferences, and body fat).
Results: The CBT group consumed significantly more fruits and juice, vegetables, and dairy in the 6-month follow-up as compared with the TAU group (p-values <0.001). The CBT group consumed significantly less sweet snacks, salty snacks, sweet drinks, sausages/processed meat, and oils in the six-month follow-up compared with the TAU group (p-values<0.001). Additionally, the waist circumference, BMI, waist-hip ratio, and fat mass were significantly decreased in the CBT group in the six-month follow-up compared with the TAU group (p-values<0.005). The CBT group significantly improved their psychosocial health, physical activity, and health-related quality of life (p-values<0.001).
Conclusion: The CBT program showed its effectiveness in reducing weight among Iranian adolescents who were overweight. Healthcare providers may want to adopt this program to treat excess weight problems among adolescents.

1. Introduction

The number of individuals that are overweight and obese is expanding rapidly worldwide [1]. It is estimated that 57.8% of the adults in the world will be overweight or obese by 2030 [1]. Moreover, excess weight as indicated by a high body mass index (BMI) has increased in both genders in Eastern and Southern Asia, and for females in Southeast Asia [2]. Being overweight is the most common risk factor for non-communicable diseases [3]. Along with adolescent obesity, childhood obesity has also become a pandemic health problem in developing countries [4]. Consequently, obesity is one of the most serious public health challenges in the present century [5]. The problem also exists in Iran (where the present study was carried out) [3]. The prevalence of being overweight and obese in children is 21% and 18.3% respectively. In addition, abdominal obesity has been reported to be prevalent in 17.6% of the Iranian adolescents [6]. Being overweight and obesity have

* Corresponding author. Social Determinants of Health Research Center, Qazvin University of Medical Sciences, Qazvin, Iran.
** Corresponding author.
E-mail addresses: mjavadi@qums.ac.ir (M. Javadi), amir.pakpour@gmail.com (A.H. Pakpour).
[1] These authors contributed equally to this work.

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increased dramatically among Iranian children since 2000 (3). Given that about 80% of obese adolescents will remain obese in adulthood [7,8], healthcare providers in Iran need to pay additional attention to the issue of obesity.

Evidence suggests that the burden of obesity on physical health starts in early life, and contributes to the development of risk factors for metabolic heart diseases during childhood and adolescence [9]. It is also associated with early death in adulthood [10]. Childhood obesity has complex causes, including genetic, environmental, physiological, and psychosocial factors [10]. More specifically, environmental factors such as lifestyle preferences and the cultural situation are important determinants in the increased prevalence of obesity globally [11]. In general, being overweight and obesity are the results of increased calorie and fat intake [11]. Also, over-consumption of sugar in non-alcoholic beverages and the continuous decline in physical activity have also contributed to the increased rate of obesity worldwide [11].

Several systematic reviews and meta-analyses have shown that weight control is possible using various interventions concerning environmental factors, such as changing a child's eating habits, lifestyles, and modifying the whole family and environment (school and community) [12,13]. The treatment of children who are overweight and obese appears easy as it typically involves advising children and their families to eat less and do more exercise [14]. However, in practical terms, the treatment of childhood obesity is time consuming, boring, difficult, and expensive. In fact, choosing the best method to treat being overweight and obesity in children is very complicated [14] and requires multicomponent interventions including medical and lifestyle interventions, psychosocial support, self-management programs, and pharmacological strategies, as well as bariatric medical procedures in extreme cases [15]. Fortunately, when obesity is treated at an early age, even a relatively low weight loss can dramatically improve child's health [16].

Therefore, interventions for overweight children are needed. One recommended treatment by the US Prevention Services Work Group is the use of lifestyle interventions [17]. Lifestyle interventions include behavioral components and cognitive skills training that focus on weight-related behaviors [18,19]. In most programs, weight-management aspects are the main components, but programs that consider behavioral approaches, cognitive rehabilitation, and prevention methods can also increase treatment efficacy [18,19]. Interventions with behavioral components that change diet and activity such as improvement of physical activity and reduction of immobility have the greatest impact on weight reduction in overweight adolescents [20,21]. Another key component of lifestyle interventions is family involvement and support. Family behavior interventions including parent involvement in the treatment process have been effective in controlling weight and developing healthy eating habits over the past 30 years [22,23].

The most successful multi-dimensional approach that influences diet, physical activity, and behavior change is the family-based approach [24,25]. Family-based behavioral intervention is an effective and safe treatment for childhood obesity, and should be considered the first treatment option [24,25]. It can ensure that parents are provided with a better access to healthy foods. Family-based weight loss programs are valuable methods for adolescents to choose healthier foods [26] and weight loss remains durable for two years [27]. Therefore, parental involvement in weight loss programs appears necessary in achieving weight-reduction goals.

One of the most up-to-date approaches to managing obesity is cognitive-behavioral therapy (CBT) [28]. More specifically, CBT can be used to reschedule the lifestyle of an individual who is overweight [29]. Children and adolescents with obesity require appropriate clinical considerations. Eating and weight problems are recognized as abnormal daily patterns including distorted cognitive and behavioral cycles [30]. The treatment of weight control issues requires a comprehensive approach, because the problem occurs in the individual, home, and social environment [30]. CBT emphasizes the process of changing habits and attitudes that sustain mental disorders. Therefore, CBT is an appropriate method in treating obesity [30]. Moreover, CBT can be incorporated with family-based therapy to achieve maximum treatment efficacy [31,32].

There are evidence-based strategies for weight loss, and many of them are beneficial for improving quality of life, and overcoming depression and unhealthy eating behaviors [33]. Given the nature of obesity and mental health, it is suggested that weight loss interventions simultaneously focus on evidence-based interventions that target weight loss (lifestyle interventions, medications or surgery depending on the individual's condition) along with a behavioral health and mental health-based intervention. This second component should include a continuous assessment of maladaptive behaviors and psychological harm [33]. There is not enough single treatment intervention to manage obesity due to its complexity [34]. Integration of psychological approaches in the clinical management of obesity in children and adolescents to effectively address the global epidemic of childhood obesity is recommended [34].

In a meta-analysis study in 2017 to evaluate the effect of psychological treatments on weight loss in obese people with eating disorders, CBT was shown to be very effective [35]. Another meta-analysis and systematic review suggested that clinical trials conducted on the effect of CBT on eating disorders were of poor quality [36]. Although the extant literature has discussed the efficacy of CBT on weight loss and health promotion among obese adolescents [37], the evidence is weak, especially for Iranian adolescents. Therefore, the present study assessed the effect of CBT on the improvement of nutritional status and weight among overweight and obese adolescents.

2. Methods

2.1. Design and setting

The present study was a prospective randomized controlled trial (RCT) comparing the effect of CBT on weight reduction among overweight and obese Iranian adolescents. The adolescents were recruited from four outpatient pediatric clinics in Qazvin (Iran). Participants were randomly divided into two groups (the treatment as usual [TAU] control group and the CBT intervention group) stratified by the outpatient pediatric clinics (Fig. 1). The inclusion criteria were as follows: age 13–18 years, BMI $\geq$85th percentile for age and gender [38], and ability to attend CBT sessions. Adolescents with the following criteria were excluded from the study sample: adolescents with other causes of obesity such as Cushing Disease and hypoparathyroidism, being pregnant, having clinical mental health conditions or psychosis, taking specific medications that affected their weight (e.g. corticosteroids, anxiolytics), and participating in another weight loss RCT. Prior to the study, the adolescents and their parents provided informed consent for participation. This study was approved by the ethics committee of the Qazvin University of Medical Sciences (IR.QUMS.REC.1395.172). The trial was registered with the Iranian Registry of Clinical Trials (IRCT2016110530707N1).

2.2. Intervention

CBT treatment sessions based on treatment strategies in the intervention group comprised six face-to-face sessions for adolescents and two sessions for their parents. In all sessions, nutritional recommendations and diet of the adolescents were evaluated. They

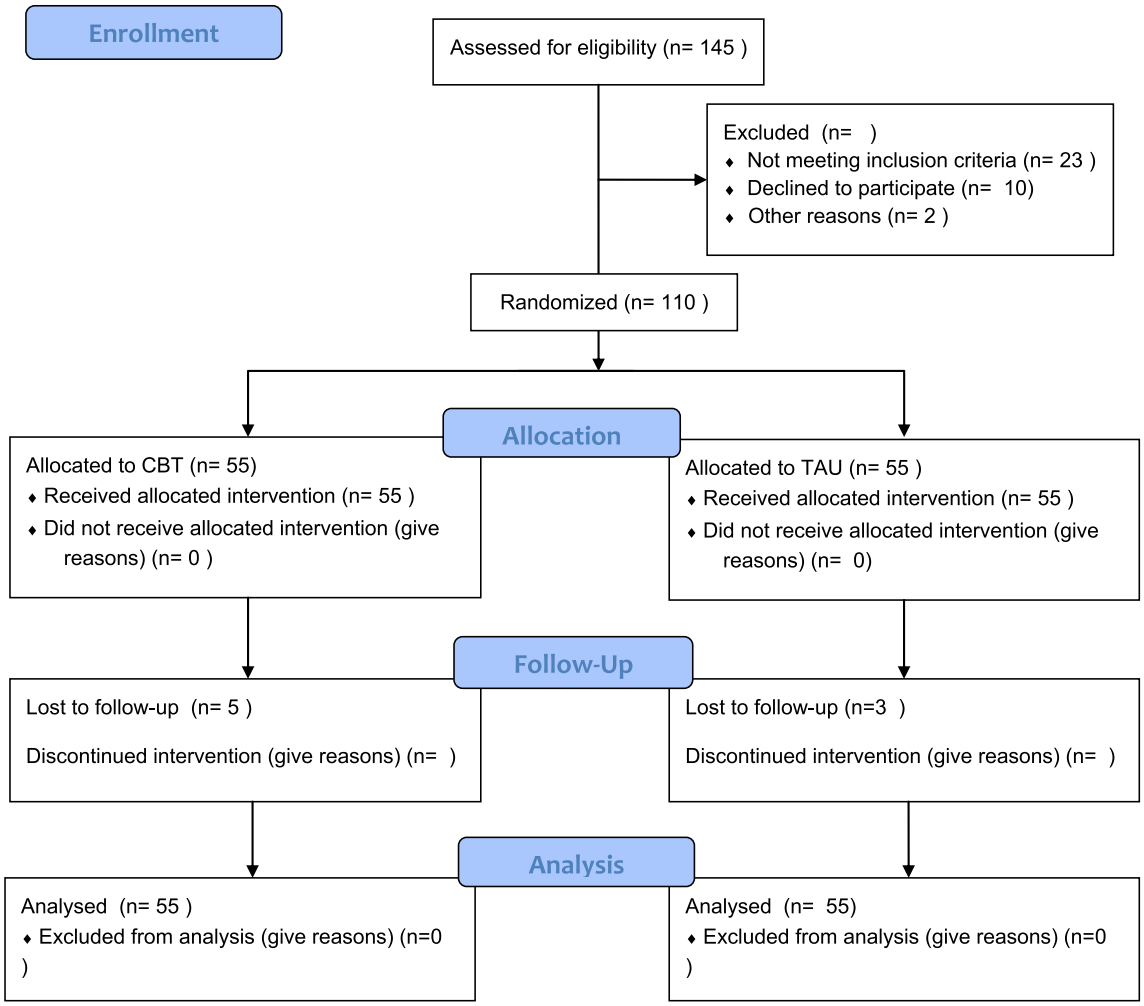

Fig. 1. Overview of selection process for the treatment program.

were asked to record their diet and physical activity for at least two days a week, and bring this information on the day of the consultation, along with their session assignments. The duration of each consultation session was between 30 and 45 min.

At the first session, a cooperative relationship between the therapist and the adolescent was developed and a history of the weight problem was taken. Definitions, prevalence, causes, and consequences of being overweight and obese, common weight loss methods, and goals were discussed. The most important issue addressed in this session was patient motivation to reduce weight. In the second to fourth sessions, behavioral strategies for changing eating habits, self-care, controlling external strategies for managing eating, initiators, and the mindset of eating behaviors were considered. At the fifth session, false beliefs (compliments, mind-reading, family misconceptions, family insistence, group pressures, etc.), emotion control, social pressure, and peer impacts were discussed. Individuals used strategies to reduce their unpleasant feelings and excitement including cravings for eating (which was the way of response to thrill), getting angry, and getting sad. Pleasant and unpleasant feelings and excitements caused craving for eating in some people, and eating due to emotional reasons tended to distract their sense of unpleasant feelings. The adolescents were taught how to avoid cravings for eating with an emphasis on prevention. New ways to enjoy life were introduced to enhance activities and have a more vibrant life. In the sixth session, weight loss, weight control, and weight management strategies were recommended so that individuals' efforts focused on learning how to minimize the risk of weight gain [39–42].

In the meetings held for their parents, definitions, prevalence, causes and problems of obesity and complications that can be created in adolescents, ways of reducing weight, and study objectives were described. After explanation of the project duration, they were asked to accompany the adolescents for implementation of the intervention.

2.2.1. Therapists and fidelity

The CBT sessions were conducted by two therapists (Master of Science in Nutrition and Master of Clinical Psychology) with 5–20 years' experience using psychotherapy in hospitals on patients who were overweight or obese. An experienced CBT therapist trained these two therapists over 100 h of supervision. In order to assess the integrity of the CBT sessions, all CBT sessions were recorded and independent raters conducted integrity checks on at least two treatments per therapist. CBT sessions were held at the pediatric clinics each week at a time held constant.

2.2.2. Treatment as usual (TAU)

Patients in the TAU condition received routine care that focused on lifestyle modification including diet plus exercise.

2.3. Randomization and blindness

Each adolescent was recruited at the pediatric clinic to which they had been referred for treatment. Randomization was performed after checking eligibility criteria, signing of informed consent, and baseline assessment. An independent biostatistician randomized the adolescents into two groups (CBT and TAU) using the SAS program (SAS Institute Inc., Cary, NC, USA) and stratifying with the pediatric clinics. Due to the nature of the intervention, neither the therapists nor participants could be blinded for the delivered treatment. However, outcome assessors and statisticians were blinded to the treatment groups.

2.3.1. Primary and secondary outcomes

Primary outcomes were assessed by monitoring changes in BMI, Child Dietary Self-Efficacy Scale (CDSS), Weight Efficacy Lifestyle questionnaire (WEL), Physical Exercise Self-Efficacy Scale (PES), Pediatric Quality of Life Inventory (PedsQL™ 4.0 Generic Core Scales), and self-reported physical activity and diet. Secondary outcomes were changes in anthropometric measures and body fat.

2.3.1.1. Weight Efficacy Lifestyle questionnaire (WEL). The WEL comprises 20 items that assess adolescents' confidence to resist eating in specific situations. All items are rated on a 10-point Likert scale ranging from 0 (*not confident*) to 9 (*very confident*) with higher scores indicating greater confidence in adolescent's ability to control eating behavior. The WEL has five subscales (negative emotions, availability, social pressure, physical discomfort, and positive activities) and a global score. Validity and reliability of the Persian version of the WEL was evaluated and confirmed in a previous study [43].

2.3.1.2. Diet. The dietary intake was assessed using a self-report food diary, the 152-item Youth and Adolescent Food Frequency Questionnaire (YAFFQ). The YAFFQ was specially developed to assess foods commonly consumed by children and adolescents aged 9–18 years. This semi-quantitative inventory contains a list of 152 food items with a standard size for each food item. During the interviews, the average size of each food item was explained to the groups, and they were asked about the frequency of consumption of each food item in the questionnaire [44]. The YAFFQ was used to estimate total energy intake (in kilocalories), total dietary fat, and servings per day of fruits, vegetables, grains, meat, dairy, sweet and salty snacks, sweet drinks, sausages/processed meat, and oils. The Persian version of YAFFQ has been found to be valid and reliable to assess Persian dietary patterns and for assessing the intake of Persian foods and beverages.

2.3.1.3. Child Dietary Self-Efficacy Scale (CDSS). The CDSS is a 15-item self-administrated scale that assesses nutritional self-efficacy among school-age children. CDSS has 15 items assessing child self-efficacy in choosing healthy, low-fat food items instead of higher fat, higher calorie food items. All items are rated on a 3-point Likert scale, ranging from "*not sure*" to "*very sure.*" The total score ranges from −15 to +15 [45].

2.3.1.4. Physical Exercise Self-Efficacy Scale. Adolescents' confidence in performing physical activity was assessed using the five-item Physical Exercise Self-Efficacy Scale (PE-SES). All items are rated on four-point scale, ranging from 0 (*not confident*) to 3 (*very confident*). The validity of this scale has been confirmed in a previous study [46].

2.3.1.5. Health-related quality of life. Adolescents' quality of life was assessed using the Pediatric Quality of Life Inventory (PedsQL™ 4.0 Generic Core Scales). The PedsQL has 23 items with four subscales: Physical Functioning (eight items), Emotional Functioning (five items), Social Functioning (five items), and School Functioning (five items). All items are rated on a 5-Likert scale from 0 (*never a problem*) to 4 (*almost always a problem*), with higher scores indicating better quality of life. Validity and reliability of the Persian version of the PedsQL™ 4.0 Generic Core has been confirmed in a previous study [47].

2.3.1.6. Physical activity. Physical activity was assessed using a seven-day physical activity recall that asked adolescents to recall activities performed in the past seven days starting from the previous day and gradually going backwards. They were asked to report the duration (in minutes), severity (according to changes in heart rate compared to walking and running), and type (daily activity or leisure activities) on each activity. Next, using the instructions given in the questionnaire, the energy consumed during the past week was calculated. The sleep time, average, and intense and very intense activities reported by the individual for each day were deducted from a score of 24 to estimate the duration of mild activities. The duration of each activity was summed up to calculate a weekly amount. The time elapsed during sleep and for each activity was multiplied by a constant number, which was 1 for sleep, 1.5 for light activity, 4 for moderate activity, 6 for hard activity, and 10 for very hard activity. To estimate adolescents' energy expenditure (in kilocalories), the scores are summed. To estimate the average amount of consumed energy on a day from the past week, the score was divided by 7. This questionnaire has been translated into Persian and was found as a useful tool for assessing the level of physical activity [48].

2.3.1.7. Anthropometric measurements and body composition. All body measurements were performed at the beginning of the study and after six months of the intervention. The weight of each adolescent was recorded using the SECA scale (SECA, Hamburg, Germany) with the least clothes and no shoes (100 g accuracy). Height was recorded using a portable 217 SECA (SECA GmbH, Hamburg, Germany) with a precision of 0.1 cm, when the heel was against the wall and the face was towards the researcher. The body mass index (BMI) was calculated with weight divided by the height in square meters. The anthropometric index of Z-scores for height-for-age, weight-for-age, and BMI-for-age were calculated as indicators of growth status for the children using Anthroplus software version 1.0.4 (WHO, Geneva) in accordance with the recommendations of the World Health Organization. Accordingly, the Z-scores < -3 SD, <-2SD, height-for-age, weight-for-age, and BMI-for-age were classified as stunted, underweight, or thin/wasted, respectively [49]. Waist and hip circumferences were recorded using a strip meter and without any pressure on the body in the precision range of 0.1 cm. The waist circumference was recorded at the umbilicus level when the person was at the end of the natural exhalation. The waist circumference was recorded on the widest part of the hip and the trochanter bone [50].

2.3.1.8. Body composition assessment. Bioelectrical Impedance Analysis (BIA) was used to evaluate body composition, record fat percentage and muscle mass using a bioimpedence analyzer (InBody 230, Biospace, Seoul, South Korea) [51].

2.3.1.9. Demographic and socio-economic factors. Information (e.g., age, gender, mothers' and father's education level, and mothers' and father's BMI) was collected using a self-report method.

2.4. Sample size

The sample size was calculated using the G × Power software package (version 3.1.9.2, Heinrich Heine University, Dusseldorf, Germany According to the Brazilian Institute of Geography and Statistics [IBGE]). To achieve at least 80% statistical power to test the medium effect size (Cohen's $d = 0.6$), assuming an α error of 0.05 and a dropout rate of 20%, a sample size of 55 participants per condition was needed.

2.5. Statistical analysis

Descriptive statistics were used to summarize the results. Continuous variables were reported as means, standard deviations, and frequencies (percentage) for qualitative (categorical/nominal) variables. The study variables were evaluated in terms of normal distribution using the Shapiro-Wilk test. Demographics, anthropometric factors, and body fat measurements were compared among the two groups (TAU and CBT) using the chi-square test for categorical variables and independent *t*-test for normally distributed continuous variables. A series of two-way repeated-measures analyses of covariance (ANCOVA), with intervention (TAU, CBT) as the between-participant variable, time (pre-post) as the within-participant variable, and age and gender as covariates, were performed to examine the effects of the intervention over a six-month follow-up. Partial eta squared (η^2) was calculated as a measure of the effect size. SPSS version 25 (IBM, Armonk NY) was used for statistical analysis, and $p < 0.05$ was considered the significance level.

3. Results

With a response rate of 75.9%, 110 adolescents participated in the study (55 in the CBT and 55 in the TAU). Eight adolescents in both groups were lost to follow-up due to migration, transfer to another school, or unwillingness to continue the study (Fig. 1). The difference in the drop-out rate was not significant between the groups ($p > 0.05$). The mean age was 14.88 years (SD = 1.69) in the CBT group and 14.64 years in the TAU group (SD = 1.5). No statistically significant differences were found between the two groups in any of the demographic characteristics and anthropometric measures at the baseline (Table 1).

Table 2 shows that except for the total calories intake (*p*-value of the interaction effect = 0.69), the CBT group improved on all the dietary and anthropometrical outcomes compared with the TAU group. More specifically, the CBT group consumed significantly more fruits and juice, vegetables, and dairy in the 6-month follow-up as compared with the TAU group (all *p*-values <0.001). The CBT group consumed significantly less sweet snacks, salty snacks, sweet drinks, sausages/processed meat, and oils in the six-month follow-up compared with the TAU group (all *p*-values<0.001). Additionally, the waist circumference, BMI, waist-hip ratio, and fat mass were significantly decreased in the CBT group in the six-month follow-up compared with the TAU group (all *p*-values<0.005).

Table 3 shows that compared with the TAU group, the CBT group significantly improved their psychosocial health (as reflected by the CDSS, WEL, negative emotions, availability, social pressure, physical discomfort scores; all *p*-values<0.001), physical activity (as reflected by positive activities, PES, self-reported physical activity length, and self-reported energy expenditure scores; all *p*-values<0.001), and health-related quality of life (as reflected by the PedsQL domain scores; all *p*-values<0.001).

Table 1
Socio-demographic and anthropometric characteristics of the adolescents.

Variables	Mean ± SD		*p*
	CBT ($n = 55$)	TAU ($n = 55$)	
Age (year)	14.64 ± 1.69	14.88 ± 1.50	0.42
Gender[a]			0.70
Boys	28 (50.91%)	30 (54.54%)	
Girls	27 (49.09%)	25 (45.46%)	
BMI (z-score)	2.18 ± 0.65	2.09 ± 0.57	0.45
Mother BMI (kg/m^2)	30.41 ± 5.01	29.45 ± 3.78	0.61
Father BMI (kg/m^2)	28.33 ± 7.12	29.46 ± 9.64	0.58
Waist circumference (cm)	108.86 ± 7.48	107.19 ± 7.48	0.24
Mother education (years)	8.93 ± 4.11	8.19 ± 4.56	0.70
Father education (years)	11.64 ± 3.87	12.07 ± 4.26	0.66
Waist–hip ratio	0.86 ± 0.05	0.85 ± 0.06	0.55
Fat mass (%)	36.15 ± 7.17	35.66 ± 6.93	0.73

CBT = cognitive behavioral therapy; TAU = treatment as usual; BMI = body mass index.
[a] Reported in n (%).

4. Discussion

The results of the present study demonstrated that the six-week CBT intervention program for adolescents alongside two sessions for parents was effective in improving the nutritional behaviors, body composition, physical activity, psychosocial health, and quality of life among obese and overweight adolescents. Moreover, the findings are consistent with previous studies using CBT on adults who are overweight and obese [18,30,52–55]: Consequently, CBT programs appear to be one of the most effective treatments for childhood obesity, and the integration of cognitive skills in such therapies improves their effectiveness [18,30,52–55].

Despite the fact that the energy intake was not statistically significant between the two groups, the composition of the consumed food was different. More nutritious and less harmful foods were consumed by the CBT group. According to previous studies, energy constraints can have a negative impact on development in adolescence [56–58]. Therefore, no changes in the overall energy intake were anticipated prior to study commencement. Also, according to international standards [56,59], it is inappropriate to reduce the energy intake in adolescents. Therefore, the focus is how to correct the pattern of food consumption. The CBT program described here is a successful intervention that corrects the food consumption pattern by improving quality of diet and providing nutritional recommendations to adolescents.

Prior research shows that self-efficacy is a major predictor for eating habits and exercise engagement [60]. Indeed, empirical evidence shows that after self-efficacy of physical activity is elevated by CBT, the actual engagement of physical activity is improved [61]. Therefore, it is suggested that apart from spending specific time exercising, adolescents are encouraged to perform a number of alternative activities that overcome their barriers to self-efficacy in physical activity [62]. The results in the present study are in line with the suggestions and findings in prior studies (59–61).

The importance of increasing self-efficacy is further supported by the lowered self-efficacy among adolescents who are overweight and obese. Studies have shown that they have much lower self-efficacy than normal-weight adolescents [63]. Adolescents with higher self-efficacy change perceptions of themselves. They know how to spend their time and energy in the best possible way because they trust their abilities to overcome difficulties and improve their performance and education [64,65]. Efforts to carry out physical activities and be resilient in the face of unsuccessful experiences are affected by self-efficacy. Because CBT strategies involve changes in thoughts, beliefs, feelings, and actions, overweight or obese adolescents are likely to improve their self-efficacy through such changes [66]. As a result, higher self-efficacy leads to better behavior [67].

Table 2
Dietary and anthropometrical outcomes in baseline and 6 months follow-up.

Measures	Baseline		6 months follow-up		Time effects		
	CBT (n = 55)	TAU (n = 55)	CBT (n = 55)	TAU (n = 55)	Time × group effect		
	Mean ±SD	Mean ±SD	Mean ±SD	Mean ±SD	F	p	η_p^2
Total calories (kcal)	2601 ± 491.8	2550.29 ± 426.87	2742.4 ± 1960.31	2630.85 ± 442.34	0.16	0.69	0.002
Grains, servings/day	13.90 ± 1.72	13.35 ± 1.90	13.18 ± 1.39	13.69 ± 1.64	17.51	< **0.001**	0.14
Meat, servings/day	2.00 ± 0.56	1.94 ± 0.53	2.42 ± 0.46	1.96 ± 0.70	17.44	< **0.001**	0.14
Fruits and juice, Servings/day	1.9 ± 0.83	1.92 ± 0.69	2.50 ± 0.60	1.83 ± 0.71	57.41	< **0.001**	0.35
Vegetables, servings/day	1.36 ± 0.64	1.36 ± 0.66	2.04 ± 0.67	1.36 ± 0.67	48.59	< **0.001**	0.32
Sweet, servings/day	1.99 ± 0.86	1.90 ± 0.99	1.42 ± 0.70	1.93 ± 0.93	41.18	< **0.001**	0.28
Salty snack, servings/day	0.6 ± 0.52	0.64 ± 0.55	0.39 ± 0.35	0.81 ± 0.59	50.10	< **0.001**	0.32
Dairy, servings/day	2.70 ± 1.27	2.70 ± 1.27	2.80 ± 0.62	2.36 ± 1.04	19.10	< **0.001**	0.15
Sweet drinks, servings/day	1.34 ± 1	1.12 ± 0.70	0.81 ± 0.61	1.15 ± 0.77	34.01	< **0.001**	0.24
sausages/processed meat, servings/day	0.46 ± 0.36	0.45 ± 0.38	0.25 ± 0.21	0.57 ± 0.39	68.16	< **0.001**	0.39
Oils, servings/day	3.58 ± 1.05	3.27 ± 1.09	3.14 ± 0.73	3.33 ± 0.95	12.65	< **0.001**	0.11
Waist circumference, cm	93.93 ± 8.77	91.74 ± 8.94	90.94 ± 9.32	93.38 ± 9.22	26.06	< **0.001**	0.19
BMI (z-score)	2.18 ± 0.65	2.09 ± 0.51	1.93 ± 0.67	2.18 ± 0.59	67.72	< **0.001**	0.39
Waist–hip ratio	0.86 ± 0.05	0.86 ± 0.06	0.84 ± 0.06	0.86 ± 0.06	8.76	**0.004**	0.08
Fat mass (%)	36.15 ± 7.17	35.66 ± 6.93	34.27 ± 7.96	37.22 ± 7.22	30.94	< **0.001**	0.26

CBT = cognitive behavioral therapy; TAU = treatment as usual; BMI = body mass index.

Table 3
Psychosocial health, physical activity, and quality of life in baseline and 6 months follow-up.

Measures	Baseline		6 months follow-up		Time effects		
	CBT (n = 55)	TAU (n = 55)	CBT (n = 55)	TAU (n = 55)	Time × group effect		
	Mean ±SD	Mean ±SD	Mean ±SD	Mean ±SD	F	p	η_p^2
Child Dietary Self-Efficacy Scale (CDSS)	3.50 ± 4.12	4.41 ± 4.89	7.65 ± 3.69	3.52 ± 4.51	78.22	< **0.001**	0.73
Weight Efficacy Lifestyle questionnaire (WEL)	92.51 ± 24.19	100.90 ± 20.37	110.94 ± 21.81	94.91 ± 22.10	85.26	< **0.001**	0.44
Negative emotions	22 ± 8.07	23.35 ± 7.02	25.63 ± 6.20	22.40 ± 6.81	27.59	< **0.001**	0.20
Availability	15.78 ± 6.32	17.78 ± 6.58	20.61 ± 6.02	16.25 ± 5.77	65.27	< **0.001**	0.38
Social pressure	18.07 ± 6.64	19.39 ± 5.74	22.47 ± 6.98	18.61 ± 6.42	34.58	< **0.001**	0.25
Physical discomfort	22.18 ± 5.78	22.92 ± 5.55	25.05 ± 4.97	21.74 ± 6.14	30.95	< **0.001**	0.23
Positive activities	14.47 ± 4.95	17.17 ± 5.25	17.16 ± 4.51	15.89 ± 5.95	26.34	< **0.001**	0.20
Physical Exercise Self-efficacy Scale (PES)	5.66 ± 0.50	5.72 ± 1.0	6.42 ± 0.58	5.37 ± 0.97	58.63	< **0.001**	0.36
Self-reported PA length	0.89 ± 0.60	0.87 ± 0.45	1.19 ± 0.58	0.31 ± 0.24	62.16	< **0.001**	0.35
Self-reported Energy expenditure	536.92 ± 636.64	405.31 ± 443.99	580.94 ± 614.62	289.63 ± 435.78	22.95	< **0.001**	0.18
PedsQL						< **0.001**	
Physical functioning	80.79 ± 13.68	81.97 ± 9.95	86.87 ± 10.83	78.06 ± 11.56	52.33	< **0.001**	0.33
Emotional functioning	73.27 ± 16.64	72.67 ± 16.75	82.90 ± 13.90	72.54 ± 16.80	29.14	< **0.001**	0.22
Social functioning	87.63 ± 14.01	86.33 ± 14.06	92.54 ± 8.49	81.45 ± 15.94	45.55	< **0.001**	0.30
School functioning	82.27 ± 14.45	82.28 ± 14.45	88.90 ± 9.84	88.90 ± 9.84	49.14	< **0.001**	0.32

CBT = cognitive behavioral therapy; TAU = treatment as usual; PA = physical activity.

The increased self-efficacy partly explained why the CBT group in the present study had reduced weight. Previous studies have shown that overweight and obese people eat more food during the periods of negative emotions due to its mood modifying effects [68,69]. Thus, controlling negative emotions helps in not increasing weight. In other words, more emphasis has been placed on programs that increase self-efficacy in individuals to overcome barriers to weight loss [70].

The results here also showed that the CBT improved adolescents' psychosocial health and quality of life. More specifically, all the quality of life domains (including physical, emotional, social, and school functions) were improved in the CBT group compared to the TAU group. There is accumulated evidence demonstrating that there is impaired quality of life in all domains for obese and overweight children [71,72]. Therefore, healthcare providers should consider applying CBT programs to improve their quality of life of their adolescent clients.

There are some limitations in this study that should be taken into account when interpreting the findings. First, the puberty status of the participants was not evaluated. Given that puberty is an important moderator in the relationship between weight status and emotional health [73,74]the present study was unable to control for the confounding effects of puberty. Future studies are thus warranted to examine whether the CBT program has different effects on overweight/obese adolescents during different pubertal stages. Second, most of the measures were self-report (e.g., YAFFQ and physical activity). Therefore, the study could not avoid well-known biases associated with self-report methods (e.g., recall bias and social desirability). Third, all the participants were recruited via outpatient clinics. Therefore, they were having or had a diagnosis regarding their weight problem and had sought treatment. Consequently, they might have had increased motivation to succeed compared to adolescents who did not seek treatment (i.e., overweight/obese adolescents in the community who have never received weight treatments or interventions) to participate in the CBT program. Future studies are therefore needed to investigate whether the same CBT program can work in a community or a school setting.

Author disclosure statement

No competing financial interests exist for any of the authors.

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